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To Mrs. N. F. Davis,
With the compliments of the writer.

A MATHEMATICAL STUDY

Froebel's Building Gifts

SEVENTH AND EIGHTH

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PRATT INSTITUTE
DEPARTMENT OF KINDERGARTENS
BROOKLYN, N. Y.
1906

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FOREWORD

NO one thing in kindergarten practice needs all the light that can be thrown upon it so much as the gift material. Froebel in his writings constantly refers to an understanding of the subject which he alone seems to have. He also refers several times to his original Seventh and Eighth building gifts, but nowhere are they to be found in the concrete.

For seventeen years Miss Glidden has been studying Froebel and trying to elucidate his ideas. We are indebted to her for numerous papers on the gifts and for inventions that either complete or supplement his original plans. The work she has done on the Seventh and Eighth building gifts will have special interest not only to kindergartners, but to mathematicians as well, as it offers a series of practical, although novel, exercises leading to a mastery of mathematical form.

Alice E. Fitts.

Pratt Institute.

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dergarten, and each child should self-actively work his way out from the concrete to the abstract. Nor should exercises in mathematical form be over-emphasized; that could only mean arrested development. In reality, all mental threads which correspond to the many unfolding sides of the child's mind must be taken up together and in a related way interwoven, so that mind-fabric is produced and not simply a mental tangle.

The series of practical exercises indicated under the Seventh and Eighth gift divisions of the cube could be made to advantage by boys and girls fifteen years old or even older, and all kindergarten normal students should make them. The work demands some patience and skill, but it also excites interest, and those who become interested like to push on to the end. In doing so, what may be discovered? How to cut complex mathematical forms in an easy way from a clay cube,—for example, the pentagonal dodecahedron, the regular isosahedron, or the regular trapezohedron. One sees that one mathematical form is related to another,—evolved from another, in fact. He sees for himself the process of unfolding, and just what controls the changes. He finds a simple way of getting at the cubic contents of complex solids, for he knows how to take them apart and rebuild them in rectangular plinths whose cubic contents can be ascertained at a glance. No one can do the suggested exercises in clay without coming to know and appreciate the beauty of symmetrical forms and to feel a reverence for the law underlying their formation.

When Cardinal Newman wrote his *Apologia pro Vita Sua*, he did a wise thing, for, agree with him or not in his conclusions, he carries you through his process of reasoning. You see the steps he took, the path over which he passed; you follow him in his thinking, you understand. So here, if one actually takes the steps, one will see the process, understand the evolution, and be able to agree or disagree with the conclusions.

Many have felt the need of understanding Froebel's complete thought for the gift material. In a paper entitled, "The Further Development and Adaptation of Froebel's System," read before the International Educational Congress at Brussels in 1880 by M. Jules Guillaume, translated by Mrs. Horace Mann and published in Henry Barnard's *Child Culture Papers*, we have a clear understanding of these needs shown, but the solution of the problem is not given. We find M. Guillaume writing:

"The practice of the kindergartens is still far from realizing the conception of Froebel; in general it has kept to the first six gifts and their dependencies. The round bodies of which glimpses are attained by the rotation of the cube attached to a double cord, and in a still more marked manner by the aspect of the cylinder in the condition of an independent body, are immediately abandoned; they are no longer met in the building plays which are limited to some of the divisions and subdivisions of the cube at rest (Third, Fourth, Fifth, and Sixth gifts). All these divisions affect the prismatic form to the exclusion of the pyramidal series, explicitly pointed out by Froebel in his description of the Seventh gift, and probably comprised in his thought for the constitution of the Eighth gift. The only elements which result are prisms whose surfaces offer us only the square, the rectangular parallelogram and the isosceles right-angled triangle. But when we pass from the bodies to the surfaces represented by the tablets, the material of the plays in use presents us, besides, with the equilateral triangle, which is evidently one of the faces of the octahedron constructed by means of the Seventh gift, and the scalene triangle which has its origin in the diagonal division of the brick of the Fourth gift, a new element which Froebel, according to all appearances, introduced into the Eighth gift. . . .

"The elimination of a whole series of bodies and the intrusion of surfaces which are attached to no solid are not simple questions of more or less; they are actually breaches into the system imagined by Froebel."

An effort is here made to bridge the gaps in the system indicated by M. Guillaume, although in a little different way from that which he intimated. In this series, the Eighth gift is the one which yields the octahedron, the rhombic dodecahedron, and so on. At first glance, the Seventh gift appears uninteresting and of little value. The odd, wedge-shaped pieces suggest little, but when one sees that the solid angles shown in the interior of the Seventh gift are the same as the exterior angles of such a form as the pentagonal dodecahedron, one begins to think possibly there is more in it. When one finds that whatever the exterior angle of a mathematical form may be, it may always be found in the interior of a rectilinear form by applying the Seventh gift cut, one feels that he has discovered a principle. And again, when one finds that the ultimate unit of the Seventh gift,

an irregular tetrahedron, is the form into a certain number of which all mathematical solids can be resolved, one could shout with Froebel, "Eureka! I have it!" It is a universal mathematical element; this is the key which unlocks all mathematical form.

Before considering the Seventh and Eighth building gifts in detail, an outline of the complete series of building gifts will not be out of place. Froebel's plan for the building gifts was as follows:

THE BUILDING GIFTS.

Third Gift.— A two-inch cube, divided once according to each dimension of space. Result, 8 small cubes.

Fifth Gift.— A three-inch cube, divided twice according to each dimension of space. Result, 27 small cubes. Some of small cubes further subdivided.

Seventh Gift.— A four-inch cube, divided three times according to each dimension of space. Result, 64 small cubes. Further subdivisions.

Fourth Gift.— A two-inch cube, divided once vertically, three times horizontally. Result, 8 small bricks.

Sixth Gift.— A three-inch cube, divided twice vertically (at right angles to each other) and five times horizontally. Main divisions show three planes cutting each other at right angles in such a manner as to divide material into $\frac{1}{3}$ and $\frac{2}{3}$ portions each time. Result, 27 bricks. Some of bricks further subdivided.

Eighth Gift.— A four-inch cube, probably divided into small bricks. Description in detail not given.

Note.— Fourth gift divided once vertically and three times horizontally
Sixth " " twice " " five " "
Eighth " " thrice " " seven " " ?

Structure of Building Gifts

The Third gift is a two-inch wooden cube, cut once according to each dimension of space. To show this inner structure, take three square pieces of paper, each 2 x 2 inches. Cut one, from without, in; a second, from within, out; and a third with two inner cuts and two outer (mediation of opposites). See Figure 1*a*. These three pieces of paper may then be interlocked so as to form the inner structure of the cube. The structure of the sphere, the cylinder, and the cone may similarly be shown. In the sphere, three circular surfaces are cut precisely as the square pieces of paper were cut; in the cylinder, two squares and one circle; in the cone, two equilateral triangles and one circle.

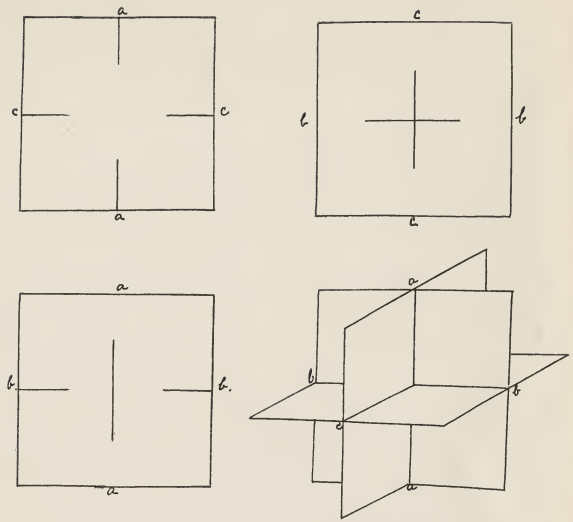


Figure 1*a*. Plan showing inner structure of Third Gift.

Carrying out this same idea, the structure of the Fifth gift may be shown. To work this out first-hand requires some thought, but it is easy to do when the plans are given, as in Figure 2*a*. In a similar manner, the structure of the Fourth gift may be shown. In Figure 4*a* the plan of the Sixth gift is given, and Figure 5*a* shows the completed form. In neither the Fifth nor the Sixth gifts are the minor subdivisions indicated, but these can easily be added.

There is no exercise which is so helpful in enabling the kindergarten normal student to understand the underlying plan of the building gifts as this exercise in cardboard work. With this underlying plan in mind, we will now make a careful study of the suggestions given by Froebel for the structure of the Seventh and Eighth building gifts.

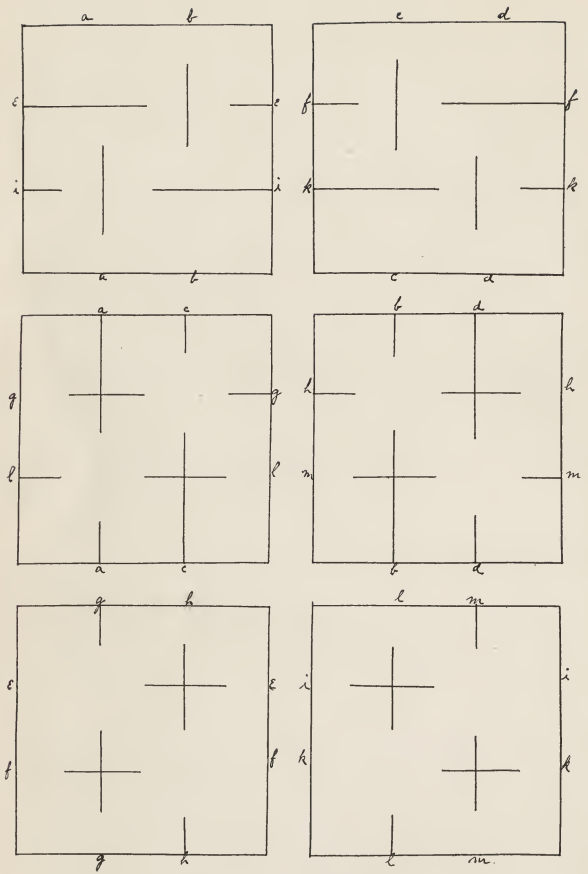


Figure 2*a*. Plan of Fifth Gift.

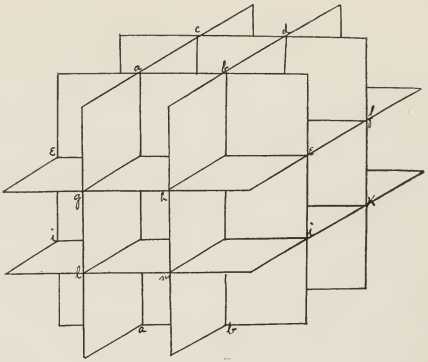


Figure 3*a*. Plan showing inner structure of Fifth Gift.

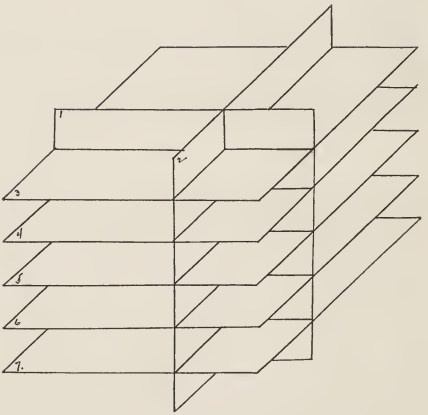


Figure 5*a*. Plan showing inner structure of Sixth Gift.

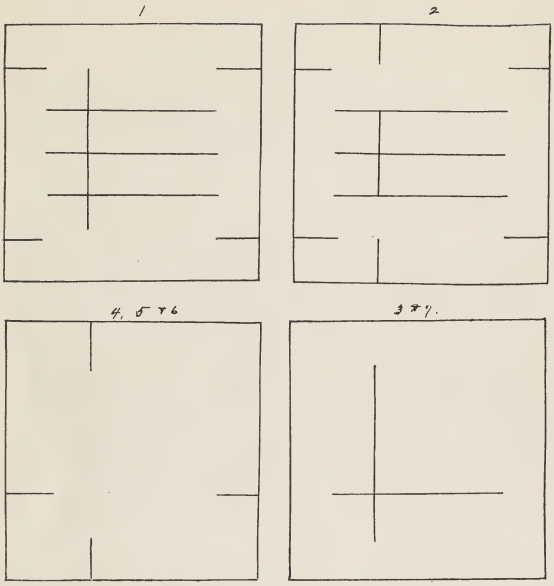


Figure 4*a*. Plan of Sixth Gift.

The illustration on the next page is an exact copy of a page in Froebel's personal diary. Translated, this reads:

Found, New Divisions.

Sunday, July 29, 1836.

Fig. 1. One cut = 2 halves, each one a three-sided column.
Fig. 2. Two cuts = 4 fourths, each = one three-sided column.
Fig. 3. Three cuts = 3 thirds, each = a four-sided point.
Fig. 4. Four cuts = 2 sixths, each a four-sided point = 3 twenty-fourths = 4 twelfths. This, the new cut!

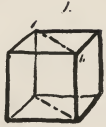
The drawings are dated, and so can be placed in their order in time in the evolution of Froebel's thought upon the gifts of

Fröbel-Museum.
Eisenach.

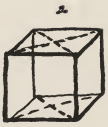
1836

Juli 29. Freitag

Hier
Schnitt.

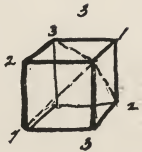


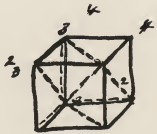
= 2 Zwölfstern
Jacke
nimm
3/1 P.



zwanzig Schnitte = 4 Achtstab
Jacke = einen 3 spitzigen Stern

3 Schnitte =
3 Sechstab
Jacke = einen
4 spitzigen Spitz /=





4 Schnitte = 2 Vierstab
Jacke einen 4 spitzigen Spitz /
= 3 Vier und zwanzig Stab
= 4 Zwölfstab

Schluß der ersten Schnitt. /

E. Heerwart.

the kindergarten. In *The Education of Man*, p. 285, we find in a footnote written by the translator, Dr. W. N. Hailmann, the following:

"Even at the date of the publication of the *Education of Man*, Froebel appreciated the value of simple playthings. . . . Not before 1835, he gained from some children playing ball in a meadow near Burgdorf the inspiration that the ball is the simplest and as such should be made the first plaything of the little child. In 1836 he had reached the first five gifts, and even among these the second gift lacked the cylinder, and the fifth gift consisted of twenty-seven entire cubes. The cylinder was added to the second gift, probably not before 1844, when the idea of the external mediation of contrasts in educational work was first clearly seen and formulated by him. In a weekly journal which Froebel began to publish in 1850, a System of Gifts and Occupations, similar to the one now used in kindergartens, is described."

The date 1836 in the diary shows that these drawings were made at the time when he had completed the first five gifts of the kindergarten and presumably was at work upon the Sixth and their immediate successors, for the cuts here indicated evidently refer to the two missing building gifts, the Seventh and Eighth, which he never completed.

We find in *Education by Development*, p. 324, the following: "Being necessarily and manifoldly conditioned, the seventh gift results from the fifth, since the cube is divided three times on each side, so into four times four times four, or into sixty-four cubes. Several of these part-cubes are again divided, from the middle and through the middle, into oblique-surfaced equal parts, one-half, one-third, one-fourth, one-sixth. By arranging them together in reference to a common center, the most important polyhedrons, the octahedron and dodecahedron, can be represented as if their germs existed in the interior of the cube, and, as it were, developed from it. This play gift is highly important, since some polyhedrons, although at first only in outward form, appear as if conditioned in and required by the interior — the middle of the gift.

"The seventh play-gift goes side by side with the eighth, which is related to the seventh as the sixth is to the fifth and the fourth to the third. The further development of the eighth gift is not given here."

In the same volume, p. 326, we find: "The third, fifth, and

seventh gifts form the series of cubical forms and the forms used in play which evolve from the cubical. They thus form the third series of children's playthings.... The fourth, sixth, and eighth gifts form the series of the brick shape, or the fourth series of children's playthings."

Following these hints, let us analyze the cube by a series of oblique cuts, and see what we get. First we obtain, *Two preliminary gifts leading up to the Seventh and Eighth and included in the Eighth gift.*

Figure 1.

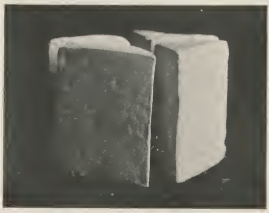


Figure 2.

Placing a knife on the diagonal of one of the square faces of a clay cube and cutting straight down, we divide the cube into two equal triangular prisms, like those of one of the small cubes divided into halves of the Fifth gift. See Figure 1.

Making a similar cut upon the other diagonal of the square face, we divide the cube into four equal triangular prisms, like the small cube divided into quarters of the Fifth gift. See Figure 2.

The Seventh Gift.

Placing the knife upon the diagonal of the square surface of the cube and cutting part way down, so that a line is made connecting diagonally opposite corners of the cube, and treating each surface of the cube in the same way, the cube will be divided into three equal irregular square pyramids. The base of each of these is the square face of the cube. Two faces are right isosceles triangles, two others are obtuse scalene triangles. See Figures 3, 4, and 5.

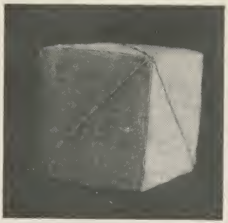


Figure 3.

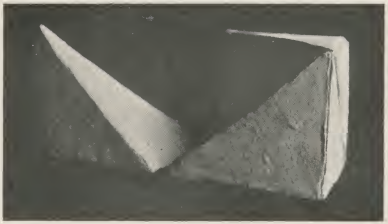


Figure 4.

Figure 5.

If each of these parts be split down the center, the cube will be divided into sixths (tetrahedra). See Figure 5*a*. These may be combined into thirds, making differently proportioned tetrahedra. See Figure 6. This manner of dividing the cube is important in its application to the analysis of other mathematical solids, as will be seen later.

Figure 5*a*.

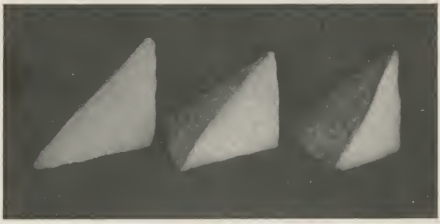


Figure 6.

The Eighth Gift.

Making two diagonal cuts upon the square face of the cube, cutting straight down, and repeating this operation with each face of the cube, we get a new series of forms. Before they are taken apart, they appear as in Figure 7.

Plucking each of the eight corners out, we have the forms shown in Figure 8. Placing these together, we have one-half

Figure 7.

Figure 8.

of a regular rhombic dodecahedron. See Figure 9. Putting two cubes analyzed in this way together, we have the complete form (Figure 10); or the cube may be separated into four upright triangular prisms, an analysis of the parts of which is shown in Figure 11.

Carried to its ultimate analysis, we have twenty-four tetrahedra (Figure 12). These tetrahedra may be combined to form three regular octahedrons (Figure 13), or one large square prism

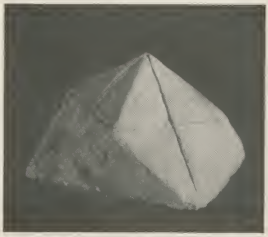


Figure 9.

Figure 10.

Figure 11.

(Figure 14), or four entirely different mathematical forms, but each having the same volume as each of the others (Figure 15).

It will be seen at once that the Eighth gift includes the two preliminary gifts; that they are useful merely in showing the steps of evolution. In the preliminary gifts, we have one cut and two cuts respectively; in the Seventh gift, three cuts, three

Figure 12.

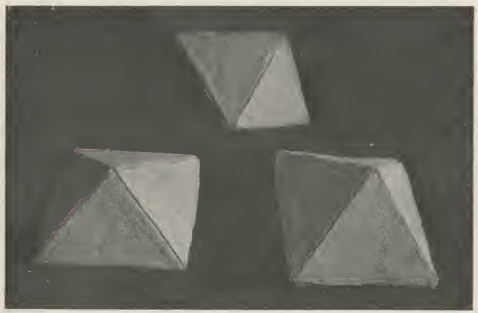


Figure 13.

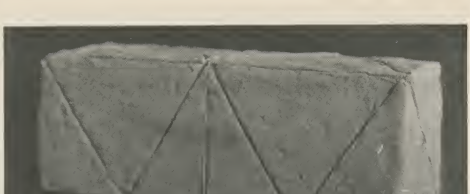


Figure 14.

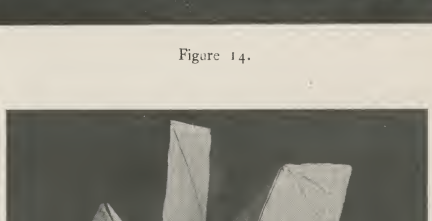


Figure 15.

square faces of the cube being each cut once diagonally. In the Eighth gift, each square face of the cube is cut twice diagonally. Hence there is a regular progression in the series.

The Seventh gift in itself yields few forms, but the method of cutting may be applied to other rectilinear solids, yielding most surprising results. It is necessary to cut the Seventh gift in clay to realize the precise relation of planes, and to see that whatever is done with one portion of the cube is done with other similar portions, so that variations coming under this cut may be understood.

Variations of the Seventh Gift. Series I.

Cutting two vertical planes parallel to each interior plane of the Seventh gift, we get a unit which approximates a rhombic dodecahedron. This solid has twelve faces, six squares and six rhombs. It should be said that the vertical planes parallel to the interior planes of the Seventh gift, instead of passing through the edges of the cube, cut through two adjoining surfaces, $\frac{1}{3}$, $\frac{2}{3}$, or $\frac{1}{2}$ of the way across, as may be decided upon. In Figure 16, each plane intersects each of the two adjoining surfaces of the cube $\frac{1}{3}$ the way across. As a result of these cuts, we have the large central unit described above, and pieces left which may be made into the mathematical solids shown in Figure 16. In Figure 17, the planes similar to those shown in Figure 16 intersect the adjoining surfaces of the cube $\frac{1}{2}$ the way across; in Figure 18, $\frac{2}{3}$ of the way across.

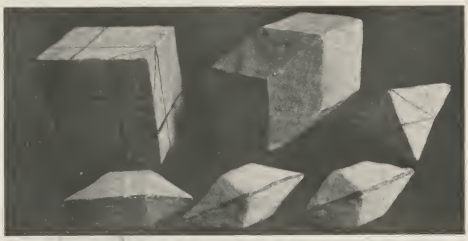


Figure 16.

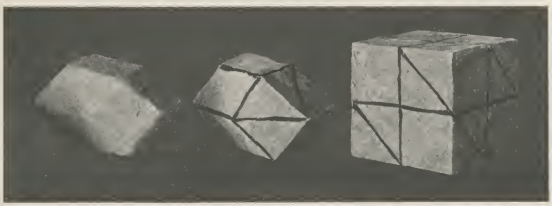


Figure 17

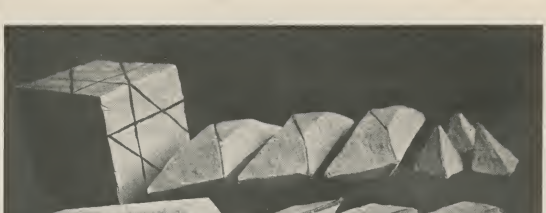


Figure 18.

Variations of the Seventh Gift. Series II.

These cuts are made through planes similar to the interior planes of the Seventh gift, but not parallel. The line made upon the square face of the cube for the initial cut now makes, with the two adjoining edges of the cube, a right scalene triangle. The large unit left in the center of the cube by these cuts is a double hexagonal pyramid. The smaller parts may be variously combined as indicated in Figure 19.

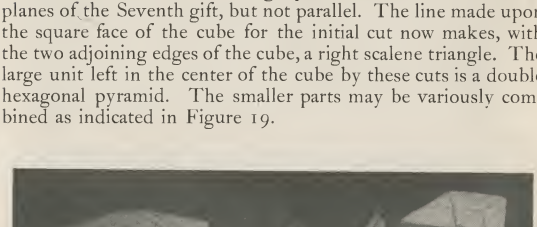


Figure 19.

Series of Cuts Taking off Corners of Cube.

Related to Seventh Gift.

In this series, divisions are made that cut off the corners of the cube. In Figure 20, the corners are cut off by diagonal planes cut from points midway across the edges of the cube. The result is what Froebel would call the "six-eight crystal form," (six square faces and eight equilateral triangles,) and the small parts may be combined to form small square pyramids.

In Figure 21, we see what happens when these diagonal cuts overlap. The points from which these diagonal planes are cut are now $\frac{2}{3}$ the way across the edges of the cube. The central solid is bounded by six squares and eight irregular hexagons. The parts may be combined into the mathematical forms shown in Figure 21.

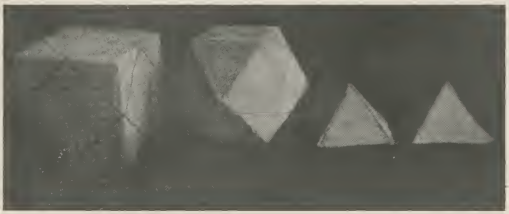


Figure 20.

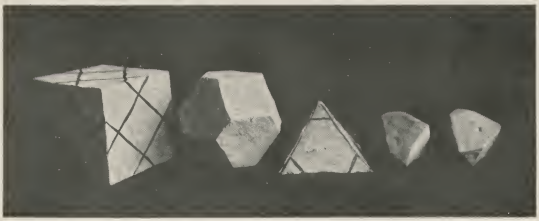


Figure 21.

In Figure 22, planes are cut as in Figure 21, but the points from which these diagonal planes are cut are now $\frac{3}{4}$ the way across.

In Figure 23, the cube is cut by planes passing through the diagonals of the surface of the cube and cutting off four ~~edges~~ corners.

In Figure 24, two diagonal cuts are made upon each surface, the opposite cut to each one made in Figure 23 being added. Result, four regular octahedrons and eight tetrahedra.

Figure 22.

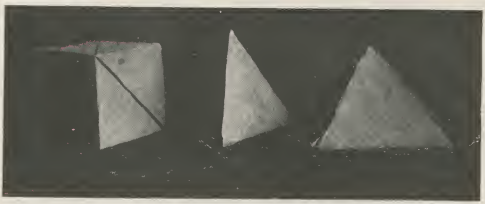


Figure 23.

Figure 24.

Application of Seventh Gift Principle.

In the rectangular prism, 9 x 6 x 1, shown in Figure 25, there are twelve small prisms each 2 x 1 ½ x 1 (six of which are further subdivided by the Seventh gift cut), and there are twelve small prisms each 1 ½ x 1 x 1 (six of which are divided into equal bricks each 1 ½ x 1 x ½), and the twelve very small prisms thus obtained are divided by the Seventh gift cut. With this material may be built the pentagonal dodecahedron shown in Figure 26, and the additional mathematical figures shown in that illustration.

Figure 25.

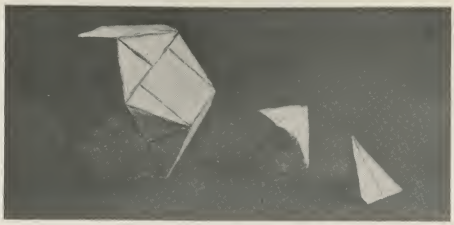


Figure 26.

The inner diagonal lines shown by the cut of the Seventh gift become the outer angles of any regular mathematical solid which has axes of approximately equal length. The slant of the outer angle depends upon the proportions of the rectilinear solid to which the Seventh gift cut is applied. This makes it possible to easily build up complex mathematical forms or with equal ease to analyze them, and secures to the one who makes this study an unusual knowledge of mathematical form, size, relative proportion, and the mental development that goes with it.

If a complex solid like a pentagonal dodecahedron can be made easily to take the form of a rectilinear plinth, its cubic contents can be ascertained at a glance; and if this rectilinear prism (analyzed in a similar but not identical manner) can be rebuilt in other forms,—for example, an octahedron or isosahedron,—then a bridge between these forms has been found and their relation to each other may easily be seen.

Every mathematical solid can be resolved into tetrahedra, similar to those of the Seventh gift, when it is divided into sixths. The proportions of the sides of the tetrahedra may vary in different forms, but the fundamental shape is the same. These tetrahedra may therefore be considered as universal units, elements, the simplest units into which mathematical forms can be analyzed.

Variations of the Eighth Gift. Series I.

In Figure 27 the planes are cut parallel to the planes of the Eighth gift, but, instead of passing through the edges of the cube, cut through two adjoining surfaces ¼, ½, or ¾ of the way across, as may be decided upon. Figure 27 shows the planes intersecting ¼ of the way across. Figure 28 shows the intersection of the planes the same as in Figure 27, but ⅓ of the way across. Figure 29, the same as Figures 27 and 28, but ½ of the way across. The central unit here is the regular rhombic dodecahedron. Figure 30 is the same as in previous cuts, but ⅔ of the way across. This gives an interesting series of garnet forms.

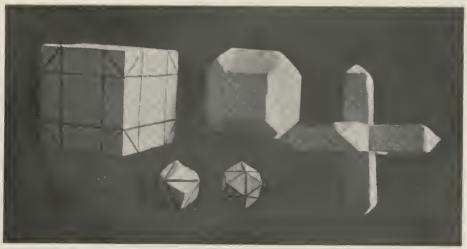


Figure 27.

Figure 28.

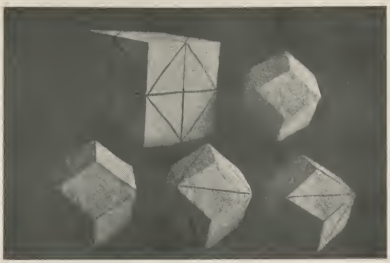


Figure 29.

Figure 30.

Variation of the Eighth Gift. Series II.

These cuts are similar to those of the Eighth gift, but are not parallel to them. The planes cut off triangular prisms, removing the edges, but the two sides of the triangle are not equal, as they must be in the Eighth gift. The bases of these triangular prisms are right scalene triangles. In Figure 31, we have, as a result of these cuts, a regular pentagonal dodecahedron, and other mathematical solids there shown.

Figure 31.

In Figure 32, we have the cut shown in Figure 31 applied to two dimensions only, the result giving one of the forms shown in Froebel's crystal box of fourteen solids, described in *Education by Development*, p. 303; this form is seen to contain the regular pentagonal dodecahedron.

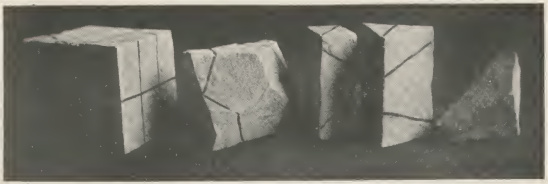


Figure 32.

In Figure 33, we have planes similar to those in Figures 32 and 31. The base of the triangular prism cut off at each edge is a right scalene triangle; one side of this triangle is $\frac{1}{2}$ the side of the cube, the second side is $\frac{1}{6}$ the side of the cube, and the third side is the hypothenuse of the triangle. The results of this cut are shown in Figure 33.

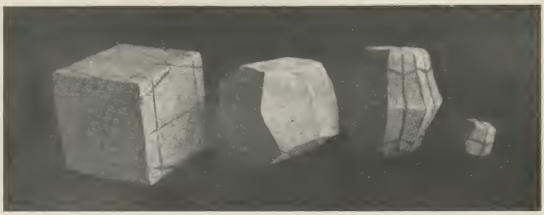


Figure 33.

Combination of Seventh and Eighth Gift Cuts.

The Eighth gift cut used in this instance takes off triangular prisms, removing each edge of the cube. The base of each triangular prism is a triangle one side of which is $\frac{1}{2}$ the side of the cube, the second side is $\frac{1}{6}$ the side of the cube, and the third side is the hypothenuse. The Seventh gift cut used takes off each corner of the cube, the cut being $\frac{1}{3}$ from the corners of the cube on the three sides cut. The result is the regular isosahedron and certain mathematical elements which may be combined in various ways. See Figure 34.

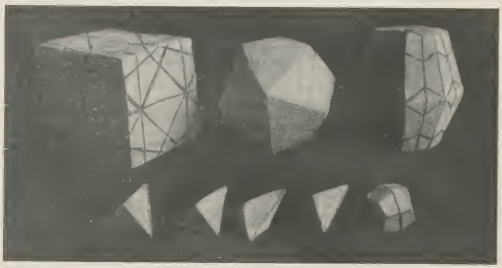


Figure 34.

Series of Cuts Taking off Corners of Cube.

Related to Eighth Gift.

Figure 35. In the Eighth gift, triangular prisms are cut off, each edge being removed; and in the variation of this cut, the base of the triangular prism becomes a right scalene triangle. Here, the surface form is a right scalene triangle, but we are no longer dealing with a triangular prism. We cut off in each instance from a corner of the cube a triangular pyramid. The base is a right isosceles triangle, two sides of which are each equal to

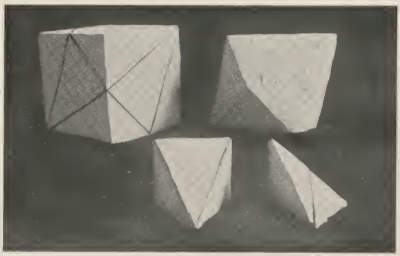


Figure 35.

one-half the side of the cube. Two faces of the pyramid are equal right scalene triangles, each having one side equal to one-half the side of the cube, the other side being equal to the whole side of the cube. Figure 35 will make clear the rest. The result is a regular double hexagonal pyramid.

Reviewing the requirements made by Froebel for the Seventh gift, it was to be a 4x4 cube, divided three times each way according to the dimensions of space into 64 small cubes. Several of these small cubes were to be again divided into oblique-surfaced equal parts, ½, ⅓, ¼, ⅙. By arranging them together in reference to a common center, the most important polyhedrons, the octahedron and dodecahedron, could be made.

Let us see how far these requirements have been met. In Figure 25 we have a rectangular plinth 9x6x1. The material in this plinth can be arranged in a cubical form 4½ inches wide,

4 inches deep, and 3 inches high. The material would then be divided twice each way according to each dimension of space into 18 bricks, each 2 x 1 ½ x 1. The cuts from front to back would be 1 ½ inches apart; the cuts from left to right would be 1 inch apart; the horizontal cuts would be 1 inch apart. Part of the resulting 18 bricks are further subdivided so that there are three sizes of bricks, A, B, and C. The bricks designated A are 2 x 1 ½ x 1; there are six whole bricks of this size. Six of A are divided, each into two equal triangular prisms. Six more of A are divided crosswise into twelve bricks (B) each 1 ½ x 1 x 1. Six of B are divided horizontally into two equal parts, making twelve bricks (C) each 1 ½ x 1 x ½. Six of A are divided by the Seventh gift cut, and six of C are similarly divided.

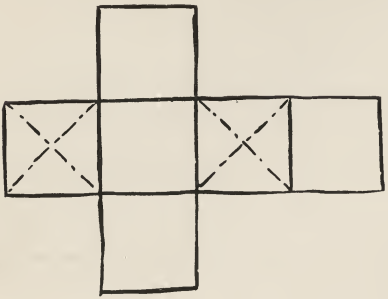
Summing this up, we have a cubical form divided twice each way according to the three dimensions of space into bricks; some of these are divided into halves and quarters, and some of the parts are divided into oblique-surfaced equal parts, ½, ⅓, ¼, ⅙. By arranging them together in reference to a common center, the pentagonal dodecahedron can be made. By a similar analysis of small rectangular prisms (bricks or cubes), material may be obtained for the building of other regular polyhedrons.

The dimensions of the unit are not so important as the manner of dividing the unit. The Seventh gift cut is the novel feature; and for this reason we have called a single cube cut in this manner the Seventh gift.

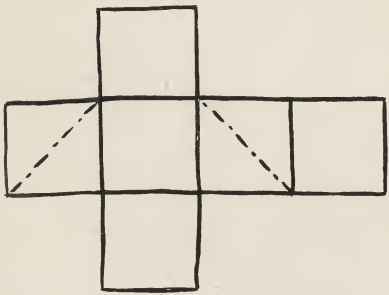
Of the Eighth gift, Froebel merely tells us that it goes side by side with the Seventh, and that the Eighth is related to the Seventh as the Sixth is to the Fifth and the Fourth to the Third.

In our series, the Eighth gift is related to the Seventh as the Sixth is to the Fifth, and it has been demonstrated that a series of interesting mathematical forms may be made from the units comprising the Eighth gift. By means of the cuts of the Seventh and Eighth gifts, the five regular mathematical solids (the tetrahedron, cube, octahedron, pentagonal dodecahedron, and isosahedron) have been shown; also the chief crystal forms (the regular rhombic dodecahedron, the double hexagonal pyramid, and others); and, most important of all, an elementary form has been shown (an irregular tetrahedron) which is a key that unlocks all mathematical form. Any mathematical solid can be analyzed into a certain number of these tetrahedra, or be built up from them, a medium of exchange and comparison thus being furnished.

The accompanying plans should be traced, cut out, and pasted together. The dotted lines will then indicate how clay cubes should be cut.

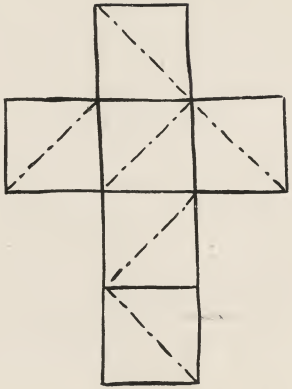


Plan of Figure 2.

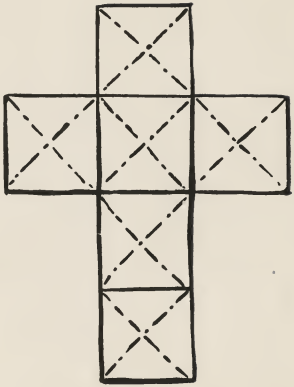


Plan of Figure 1.

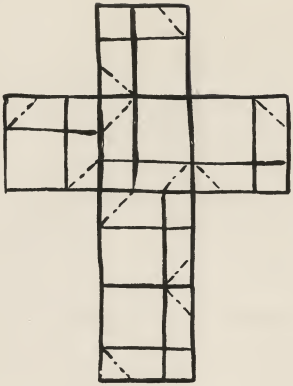
Here are six faces of the cube. Imagine them made into a cube, with the knife placed upon the diagonal lines.



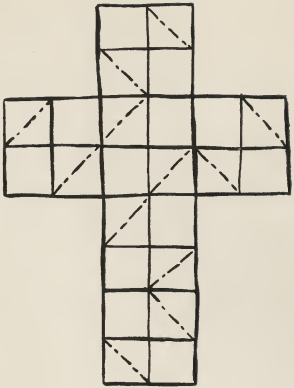
Plan of Seventh Gift. Figure 3.



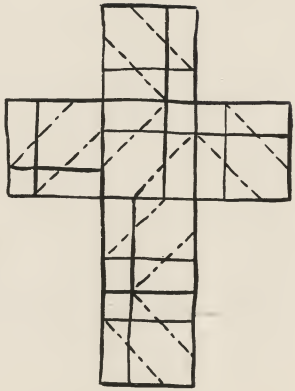
Plan of Eighth Gift. Figure 4.



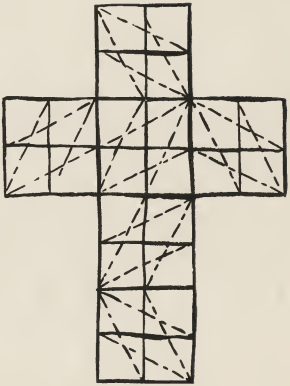
Plan of Figure 16.



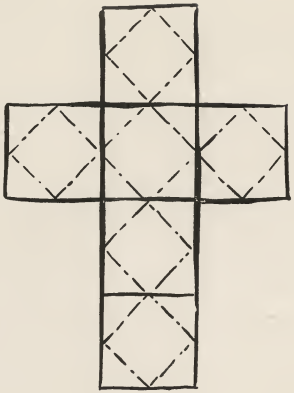
Plan of Figure 17.



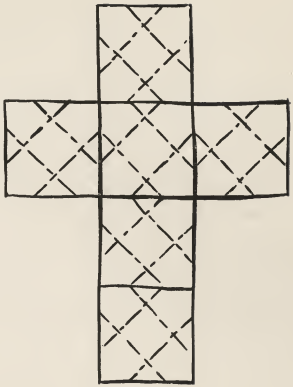
Plan of Figure 18.



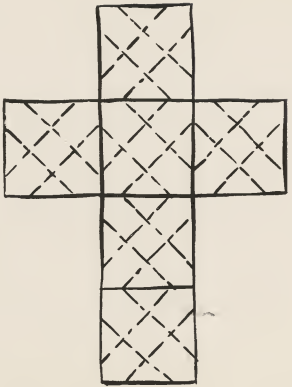
Plan of Figure 19.



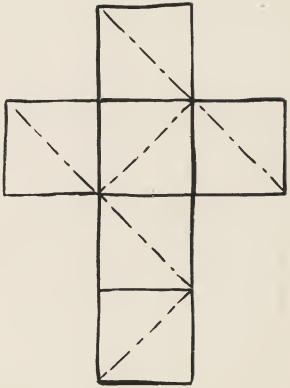
Plan of Figure 20.



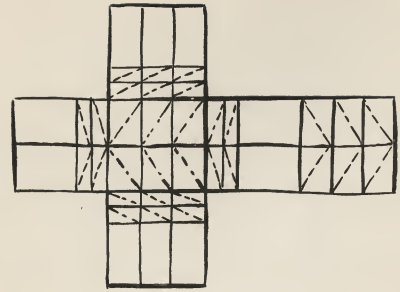
Plan of Figure 21.



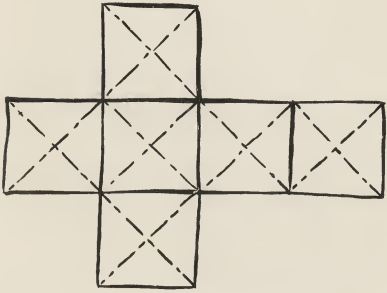
Plan of Figure 22.



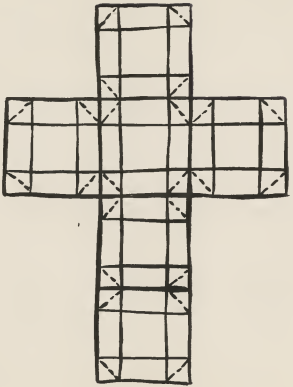
Plan of Figure 23.



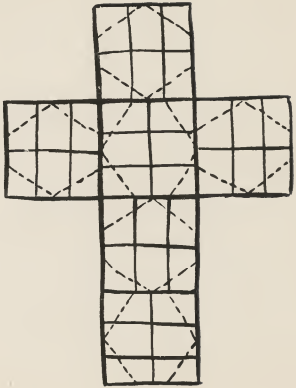
Plan of Figure 25.



Plan of Figure 24.



Plan of Figure 27.



Plan of Figure 31.

The work here submitted does not correspond closely in all details with the hints left by Froebel for the Seventh and Eighth building gifts, but the results obtained in both cases are similar and furnish an interesting basis for further study.

M. M. Glidden.

Pratt Institute, Brooklyn, N. Y.
July, 1906.

The Marion Press, Jamaica, Queensborough, New-York.

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